



Richland County Macroburst and Tornado Event July 29, 2011 National Weather Service Glasgow Storm Survey Summary



On the evening of July 29, 2011, strong thunderstorms formed over northeast Montana. A tornado touchdown was reported by the public at about 7:50pm (all times are MDT) near the town of Lambert. Many reports of large hail were received as well as reports of considerable wind damage in and near the town of Savage. The NWS radar at Glasgow had indicated a possible tornado intermittently from 7:28pm to 9:03pm. The NWS conducted a damage survey the following morning and afternoon in the area of reported damage and along the radar-indicated possible tornado track.



Fig. 1. Damage to attached garage of a house west of Savage, MT. Garage door and garage wall on left side of photograph were ripped off and deposited some 200 feet downwind.

Results From Damage Survey

The NWS conducted a damage survey during the day on July 30. The area surveyed was from just northwest of Enid, MT to just south of Savage (Fig. 2). Figure 2 shows the location of damage surveyed, and the location of the tornado reported near Lambert. The red dots plotted in Fig. 2 are the location the KGGW radar indicated a possible tornado. Arrows show the direction debris moved or trees or crops fell.

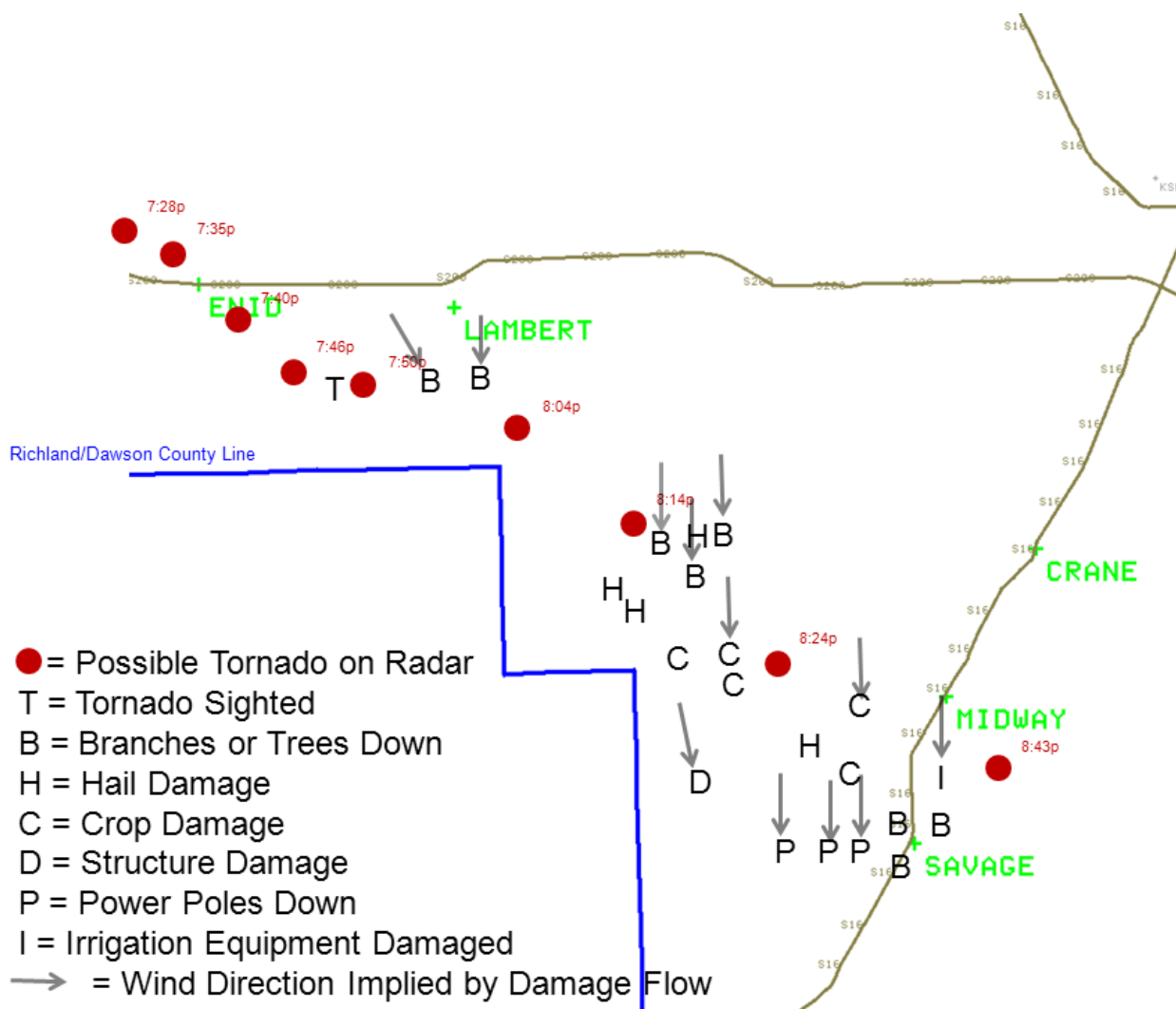


Figure 2. Area with surveyed storm damage on 7/29/11 from Enid, MT to Savage. State highways 16 and 200 are included for reference as brown lines.



Figure 3. Car damaged by hail on Rd 115 southeast of Lambert

Some light damage consisting of tree branches down and fence damage was noted south of Lambert. More significant damage was found about 9 miles southeast of Lambert on Rd. 115. At this location, numerous trees were uprooted or snapped (Fig. 4), and there was damage to homes and vehicles (Fig. 3). Residents reported hail up to 2.5 inches breaking windows in homes.

Major to minor crop damage was seen over a large area from 9 southeast of Lambert to Savage (Fig. 5). An irrigation system was destroyed just north of Savage (Fig. 6). There was some damage to structures in and near the town of Savage, with the most significant structural damage surveyed occurring on a ranch 6 miles west-northwest of Savage (Fig. 1 and Fig. 7). At this location, an attached garage was destroyed with the garage door torn off and a wall blown out. Fig. 7 shows the garage door and wall, which were blown 200 feet down wind of the house. Also, this ranch had a grain bin torn off its foundation and blown a half mile down wind, where it was found in a mining pit.

About 4 miles of power poles were blown down or snapped along Rd. 107 west of Lambert (Fig. 8). Figure 8 shows that the poles on the south side of the road were blown down, while those on the north side were not, even though those on the south side were thicker poles. The poles that were blown down were a little taller than those that did not get blown down, and had cross members near the top.

In the town of Savage, numerous trees were uprooted or snapped. Figure 9 shows the cemetery at Savage, where most of the trees were blown down.



Figure 4. Line of trees down along Rd 115 southeast of Lambert



Figure 5. Crop damage near Savage, MT.



Figure 6. Damaged irrigation equipment north of Savage, MT.



Figure 7. Wall and door torn off of garage attached to house on the left of the image.



Figure 8. Power poles down along Rd. 107 west of Savage, MT.



Figure 9. Trees down in Riverview Cemetery, Savage, MT.

Crop damage occurred as far south as County Road 107, with hail also being reported. However, significant structural and tree damage was reported by the public (not surveyed) further south, without hail also being reported. Figure 10 shows a dairy 2.4 miles west-southwest of Savage with considerable damage and Figure 11 shows a metal cable tower that was topped on County Road 105. All of the debris from the dairy in Fig. 10 appears to have been blown down wind towards the south.



Figure 10. Greenway Dairy 2.4 miles west-southwest of savage. North is towards the upper right of image. Debris was blown towards the south. Photo courtesy of D. J. Roberts.



Figure 11. Damaged metal tower on Co. Rd. 105 about 2 miles southwest of Savage, MT. Image courtesy of Charity Schmierer.

The perception of the residents of Savage was that they experienced a tornado. This is a reasonable perception as the residents first received a tornado warning from the NWS, then lost power, and then experienced powerful damaging winds. However, all of the damage surveyed flowed primarily in one direction, towards the south. Also, the damage extended over a wide area exceeding 4 miles in width, and tornadoes are much more localized. In fact, this wide area of damage is more significant than that produced by most tornadoes.

As all of the observed damage implied flow from the north, it was concluded that the damage was caused by a strong macroburst. A macroburst is defined as a strong downdraft from a thunderstorm affecting a path of greater than 2.5 miles. A macroburst forms when hail and rain aloft fall and entrain air, forming a downdraft. As large hail has a high fall speed, strong downdrafts can develop in storms with a lot of large hail (which this storm had). When the downdraft impacts the ground, the flow spreads out horizontally, creating strong straight line winds which radiate out from the center of the downdraft along a gust front. The rotation of the storm can add to the downdraft effect, creating a large area of uniform wind direction. Radar indications did not show large hail approximately south of County Road 107, which agrees with surveyed crop damage and public reports. However, significant damage still occurred for at least several miles south of Rd. 107. It is not unusual for gust fronts to travel considerable distances away from the storms which produce them, which evidently happened in this case.

The maximum wind speeds with this event are estimated from the resulting damage. Uprooted and snapped hardwood trees, building damage, and broken power poles are all consistent with winds above 95 mph over a wide area, with winds up to about 110 mph for the most significant damage.

The survey team did not find any damage from a tornado at any location, though one was conclusively observed (see Fig. 15). This is not surprising as the time the tornado was observed, when combined with radar indications of a possible tornado, place the tornado in an empty area just southwest of Fox Lake near Lambert. A tornado in this location would not have left behind any damage for the survey team to catalog.

Radar and Meteorological Data

Figure 12 shows the situation at 5:00 pm, about the time of initiation. In this image, storms can be seen erupting along a line of cumulus located on the east edge of a surface trough of low pressure. The west-east dewpoint gradient is noteworthy. Dewpoints are in the 40s west of the line of cumulus and in the 60s east of it. There is also westerly surface flow west of line and south-southeasterly flow east of it. This line is similar to a dryline more commonly seen in the southern plains. Drylines are common locations for storm initiation.

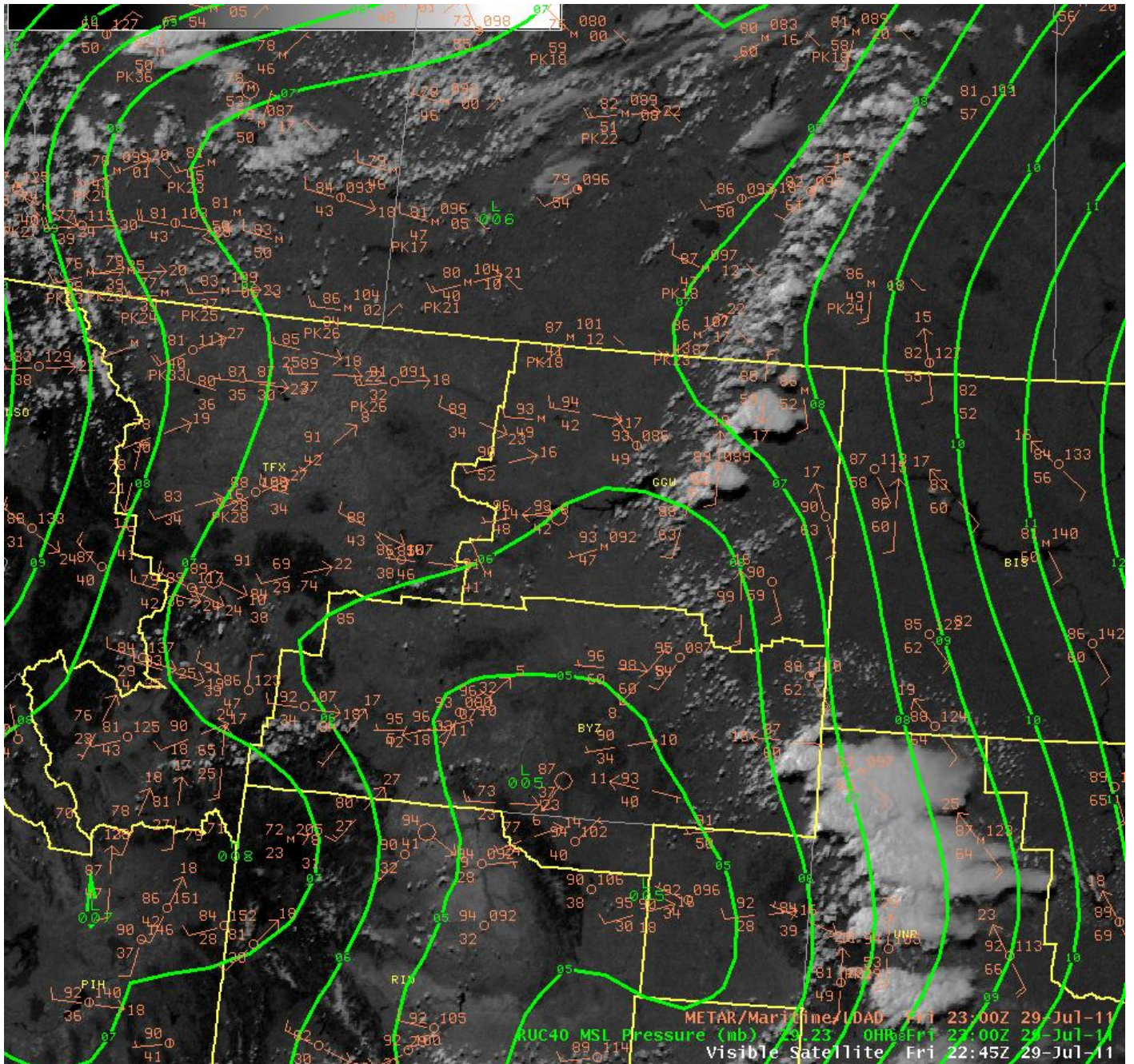


Figure 12. Surface conditions and satellite image for 5:00 pm 7/29/11. Green contours are the RUC MSLP analysis, orange data and barbs (a full barb is 10 kts) are surface station reports (with temperature, dewpoint, MSLP, wind, and wind gust plotted), and the image is the visible satellite image.

Figure 13 shows the 500mb heights and winds, along with the lifted index (LI) in shades of grey. This upper air pattern is not strongly forced, but some disturbances in the flow are apparent as wiggles in the 500mb height lines. The instability, as measured by the LI is negative (unstable) east of the dryline

at about -8 (moderately unstable). The 500mb winds of about 40 kts provide ample shear for severe storms when combined with southeasterly flow at the surface.

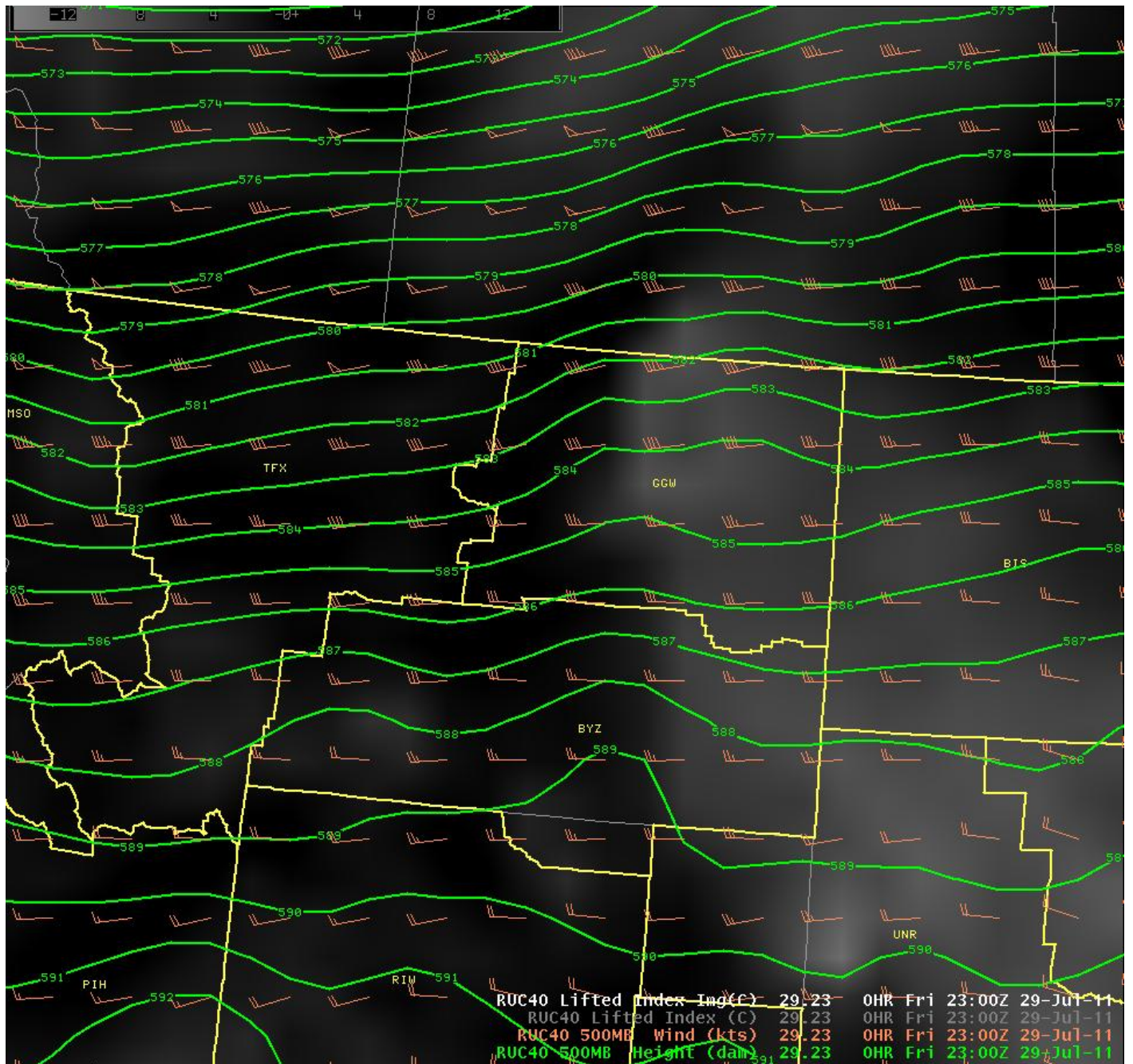


Figure 13. 500mb plot and lifted index (gray shades) for 5:00 pm 7/29/11. Full wind barbs are 10 kts.

Figure 14 shows the KGGW radar data at the time of the strongest tornado indication. The top part of Fig. 14 shows the radial velocity. This shows a mesocyclone over the Enid to Lambert area with an embedded strong, local velocity couplet just west-southwest of Lambert. This velocity couplet is co-located with the tip of the hook in the reflectivity (bottom of Fig. 14), a typical place for a tornado to be. The velocity couplet also corresponds closely with the location of the spotted tornado 4 minutes later (Fig. 15). The radar is located in Glasgow, MT. At this distance from the radar, the radar beam is about 11 000 feet above the ground, so the velocity couplet is not proof of a tornado on the ground. That proof is provided by Fig. 15. Elevated velocity couplets; however, are the primary tool for radar detection of tornadoes, as they often precede tornado touchdown.

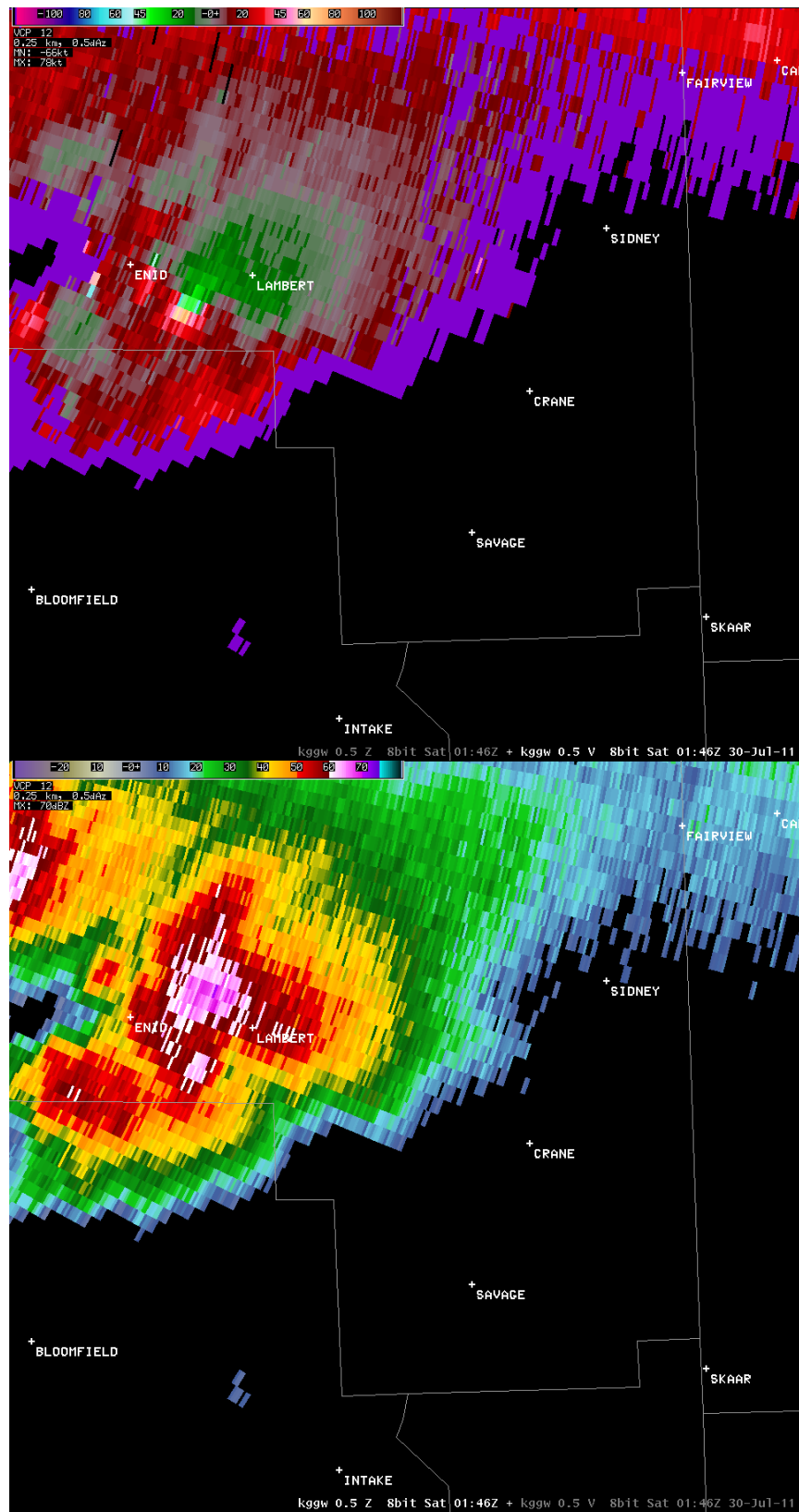


Figure 14. Radial velocity (top) and reflectivity (bottom) at 7:46 PM 7/29/11. KGGW radar.



Figure 15. Photograph of tornado near Lambert taken at 7:50 pm 7/29/31 by Andrea Zelinsky.

Figure 16 shows the radar data as the storm approached the town of Savage. At this time, the radial velocity (top of Fig. 16) shows a strong mesocyclone (with winds over 100mph measured northwest of Savage) and an embedded localized velocity couplet. However, in this case, no tornado was observed to touch down. The hook echo (Fig. 16 bottom) is very dense and corresponds with the area of 100+ mph northwest wind as seen by the radar aloft. Descending hail and rain in this area (known as the forward flank downdraft) accounts for the extreme straight line winds seen at the surface (the macroburst).

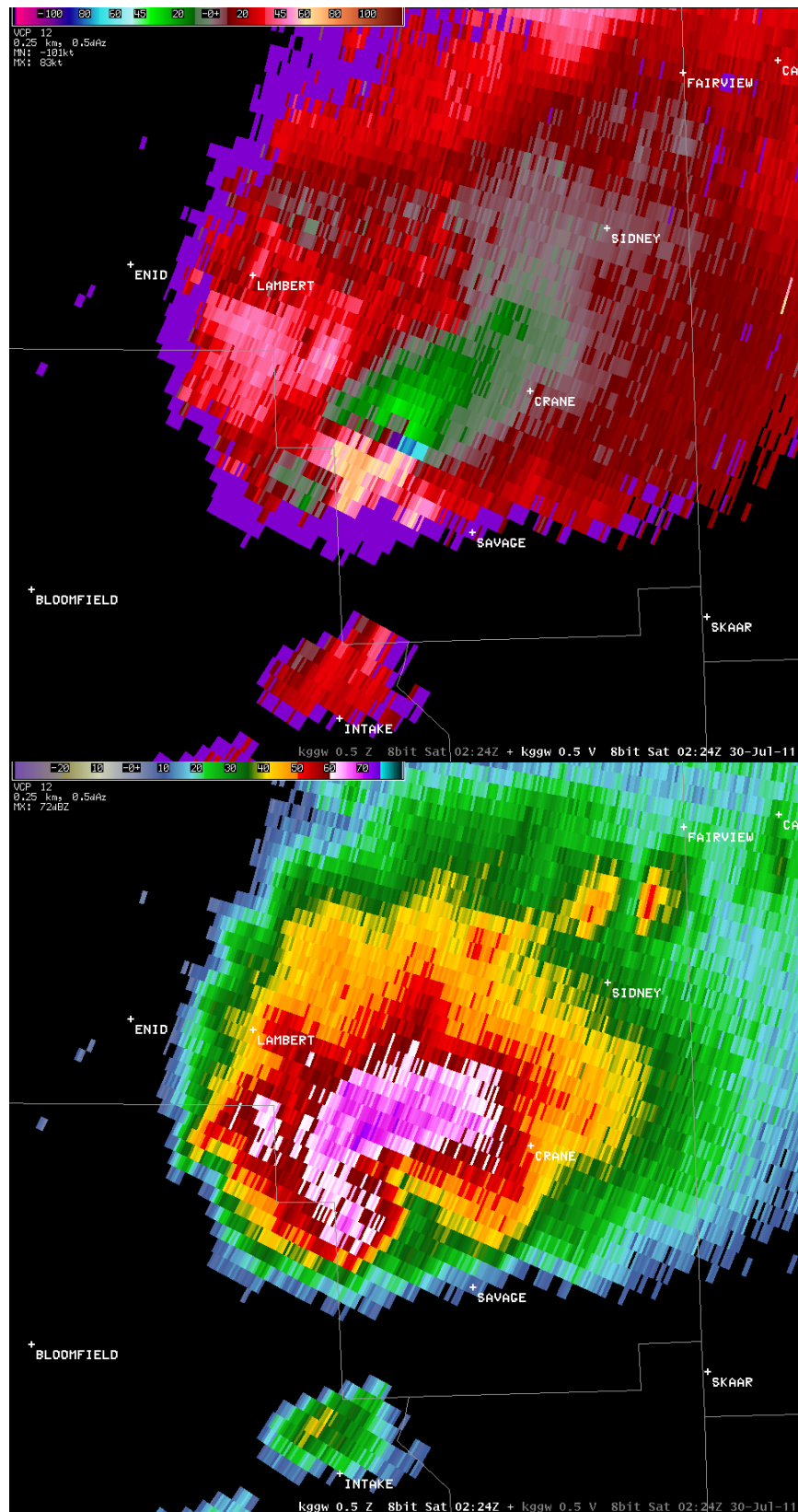


Figure 16. Radial velocity (top) and reflectivity (bottom) at 8:24 PM 7/29/11.

Public Information Statement Issued 7/30/2011

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PUBLIC INFORMATION STATEMENT
NATIONAL WEATHER SERVICE GLASGOW MT
814 PM MDT SAT JUL 30 2011

...PUBLIC INFORMATION STATEMENT...

...FINAL DAMAGE SURVEY RESULTS FOR RICHLAND COUNTY...

...DAMAGE SURVEY RESULTS FOR SIGNIFICANT STORM IN RICHLAND COUNTY ON 7/29/11...

THE FOLLOWING IS A FINAL ASSESSMENT FOR THE DAMAGE THAT OCCURRED OVER
RICHLAND COUNTY ON 7/29/11.

- * EVENT DATE: 7/29/11
- * ESTIMATED START TIME: 7:20PM MDT
- * EVENT TYPE: STRONG MACROBURST AND BRIEF TORNADO
- * EVENT LOCATION: RICHLAND COUNTY
- * PEAK WIND: 110 MPH
- * AVERAGE PATH WIDTH: N/A
- * PATH LENGTH: N/A
- * INJURIES: 0
- * FATALITIES: 0
- * DISCUSSION/DAMAGE:

A POWERFUL THUNDERSTORM STRUCK THE SOUTHWEST PART OF RICHLAND
COUNTY THE EVENING OF JULY 29...WITH REPORTS OF SIGNIFICANT DAMAGE
AND A TORNADO SITING.

THE NWS SURVEYED THE AREA FROM NEAR ENID TO AROUND SAVAGE...
WHICH WERE AREAS WITH REPORTS OF SIGNIFICANT DAMAGE AND RADAR INDICATIONS
OF A POSSIBLE TORNADO.

THE HEAVIEST DAMAGE WAS AROUND AND WEST OF THE TOWN OF SAVAGE. DAMAGE
INCLUDED A 4 MILE LINE OF POWER POLES SNAPPED ON ROAD 107 WEST OF SAVAGE...
NUMEROUS TREES UPROOTED OR SNAPPED ABOVE GROUND IN AND AROUND SAVAGE...
DESTROYED IRRIGATION EQUIPMENT...AND DAMAGE TO HOUSES INCLUDING BROKEN WINDOWS
AND ROOF DAMAGE. A RANCH 6 WNW OF SAVAGE RECEIVED THE MOST SIGNIFICANT
STRUCTURAL DAMAGE WITH AN ATTACHED GARAGE ON A WELL-BUILT HOUSE DESTROYED.

LARGE AREAS OF SIGNIFICANT CROP DAMAGE WERE ALSO OBSERVED IN THE SURVEYED AREA.

SIGNIFICANT HAIL AND WIND DAMAGE WERE ALSO OBSERVED IN THE AREA 9 MILES SOUTHEAST OF LAMBERT. THIS DAMAGE CONSISTED OF NUMEROUS TREES UPROOTED OR SNAPPED...ALONG WITH BUILDINGS AND A VEHICLE WITH BROKEN WINDOWS FROM REPORTED HAIL.

ALL OF THE SURVEYED DAMAGE WAS THE RESULT OF STRAIGHT LINE WINDS OR HAIL. THE AREA AROUND SAVAGE...IN PARTICULAR...WAS STRUCK BY A LARGE MACROBURST WITH WINDS IN PLACES EXCEEDING 100 MPH.

THE PUBLIC REPORTED AN OBSERVATION OF A BRIEF TORNADO NEAR LAMBERT. PHOTOGRAPHS SUBMITTED BY THE PUBLIC OF THE EVENT CONCLUSIVELY SHOW A TORNADO OCCURRED WITH THIS EVENT. HOWEVER...NO DAMAGE WAS FOUND FROM THE TORNADO AS PART OF THE NWS SURVEY. THIS IS NOT SURPRISING AS MUCH OF THE AREA IS OPEN COUNTRY WITHOUT TREES...BUILDINGS...OR OTHER THINGS FOR A TORNADO TO DAMAGE. WHILE A TORNADO DID OCCUR...MOST...IF NOT ALL...OF THE DAMAGE WAS FROM STRAIGHT LINE WINDS IN A POWERFUL MACROBURST.

PEAK WINDS IN THE MACROBURST WERE ESTIMATED FROM THE DOWNED POWERLINES...TREE DAMAGE...AND DAMAGE TO BUILDINGS. WINDS EXCEEDED 95 MPH OVER A LARGE AREA WITH WINDS UP TO 110 MPH FOR THE MOST SIGNIFICANT DAMAGE.

A DETAILED REPORT WITH A DAMAGE MAP AND IMAGES WILL BE AVAILABLE ON THE GLASGOW NWS WEBSITE BY MONDAY EVENING AT WWW.WRH.NOAA.GOV/GGW/.

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FOR REFERENCE...THE ENHANCED FUJITA TORNADO SCALE CLASSIFIES TORNADOES INTO THE FOLLOWING CATEGORIES:

EF0...WIND SPEEDS 65 TO 85 MPH.
EF1...WIND SPEEDS 86 TO 110 MPH.
EF2...WIND SPEEDS 111 TO 135 MPH.
EF3...WIND SPEEDS 136 TO 165 MPH.
EF4...WIND SPEEDS 166 TO 200 MPH.
EF5...WIND SPEEDS GREATER THAN 200 MPH.

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